

**PRELIMINARY
TRAINEE'S GUIDE
for
ELECTRONICS TECHNICIANS**

**Shipboard Equipment
Indoctrination Course
TELECOMMUNICATIONS EQUIPMENT**

**VOLUMES 1 and 2
INFORMATION SHEETS
ASSIGNMENT SHEETS
JOB SHEETS**

September 1967

FOREWORD

The Preliminary Trainee's Guide for Telecommunications Equipment contains the Information Sheets, Assignment Sheets, and Job Sheets for the applicable portion of the Electronics Technicians, Class C, Shipboard Equipment Indoctrination Course.

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INTRODUCTION

SAFETY

Extreme danger of personal injury or damage to equipment is present when power is applied to electronics equipment. It is imperative that all safety precautions and warnings given in the technical manuals be followed when performing the procedures given on the job sheets. The safety requirements of NavShips Technical Manual, Chapter 9670, should be observed.

HOW TO USE THIS GUIDE

This trainee guide does not supersede any existing publications, but, supplements the information contained in the technical manuals utilized in the course. The primary purpose of this guide is to provide self study material that requires a minimum of supervision.

The trainee should study the information sheets and reading assignment, answer the self test items, and perform the job sheets as directed.

FUNDAMENTALS OF TELECOMMUNICATIONS

INTRODUCTION

This information sheet has been prepared to help the trainee gain an understanding of telecommunications and the telecommunications system. The vocabulary to telecommunications is developed in parallel with the new theoretical concepts as a logical development follows for the trainee. This introduction is a compendium of several information sheets previously used in the course.

INFORMATION

Information on telecommunications fundamentals can be found on the following pages:

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FUNDAMENTALS OF TELECOMMUNICATIONS

CODE USED

The code used in a teletype system is the Baudot code. It is a current on or marking, and a current off or spacing code, and is a five unit or impulse code. It provides for transmission of the letters of the alphabet, the numerals, the commonly used symbols and machine functions such as line feed and carriage return. The provisions are made by using the 32 combinations that the five unit code permits.

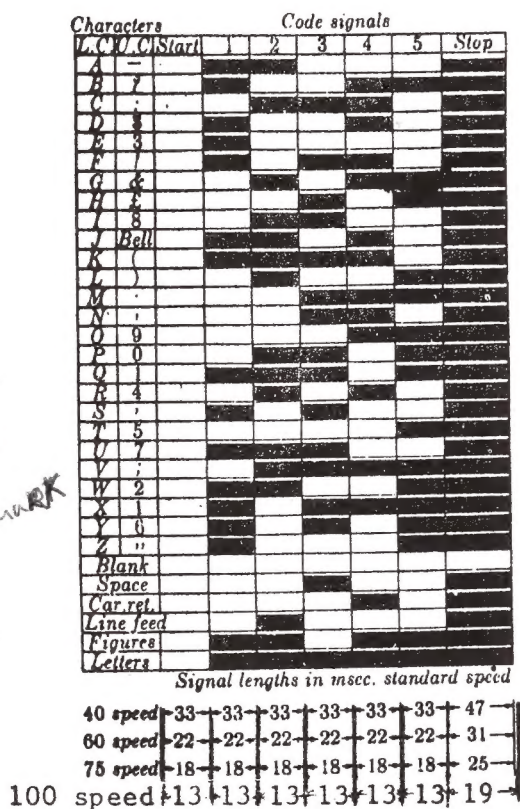


Figure 1 Teletype code

The machine then must be so designed that when a certain letter key is operated at the sending machine, the marking and spacing signals corresponding to the code for that particular key are sent out on the line. When this signal combination comes in at the receiving machine a type bar is selected and operated to print the letter. Each code character consists of five units of equal duration. The black units in Figure 1 represent marking impulses. Teletypewriters are synchronized by means of a start-stop system. That is the machines, instead of operating continuously, are started at the beginning of each five-unit group and stopped at the end of the group. This insures that the transmitting and receiving machines are always in exact synchronism at the beginning of the transmission of each character. The start-stop system corrects timing differences that may exist so that printing errors are not likely to occur. It re-

quires, however, that two synchronizing current pulses be transmitted for each character.

The first synchronizing pulse is a spacing pulse which precedes the five unit group and sets the receiving machine in operation. The stop impulse is a marking impulse at the end of the five-unit group which stops the receiving mechanism. The start impulse is equal in duration to each of the five code impulses while the stop impulse is 1.42 times as long. The duration of each impulse at speeds of 40, 60, 75 and 100 words per minute is in Figure 1.

WHY A SPACE IS 22 MILLISECONDS LONG AT 60 WPM

Using the start and selector impulses as units, the sending distributor is so constructed that six open or closed impulses of one unit each, and one stop impulse of 1.42 units are consecutively produced for each character transmitted.

The average word is assumed to consist of five letters and a space and it therefore requires six revolutions of the distributor brush arm for transmittal. At 60 WPM speed, there are 60 times 6 or 360 revolutions per minute of the brush arm. However, as the brush arm is stopped and started once every revolution, the distributor driving shaft is operated at slightly above this speed, that is, approximately 368 instead of 360 revolutions per minute. In one complete revolution, which requires 60 sec/368 or 0.163 seconds per revolution (163 milliseconds), the brush arm passes over 7.42 units. Therefore, when operating at 60 words per minute, the time for each unit signal impulse is approximately 22 milliseconds and the time for the long impulse is 31 milliseconds.

SPEEDS AND BANDWIDTH REQUIREMENTS

Three methods of indicating the speed of transmission of teletype signals are in common use:

Words per minute. In indicating speeds of transmission, a standard word is considered to consist of six characters. Spacing between words and machine functions, such as carriage return, represent additional operations that must be performed by the operator. The speed with which traffic is passed by manual operation of teletype depends on the skill of the operator until the limiting speed of the machine is reached. In automatic transmission using perforated tapes, an operating speed of 60 or 100 words per minute is commonly employed.

Cycles per second. A teletype operating speed of 60 words per minute requires the transmission of five code impulses, each each of 22 milliseconds duration together with a start impulse of 22 milliseconds and a stop impulse of 31 milliseconds duration. Each signal impulse may be considered to be a half cycle of a square waveform. The duration of a complete cycle is therefore 44 milliseconds and frequency of the cycles per second is $1000/44$ or approximately 23 cycles per second. The teletype square waveform is built up of a fundamental of 23 cycles per second plus odd harmonics. Teletype equipment operates satisfactorily if the fundamental and the third harmonic, 69 cps, is transmitted. This requirement must be met in teletype systems employing landlines and radio links. The duration of the complete cycle will be different for each speed.

Bauds Teletype transmitting speeds are sometimes stated in bauds. The speed in bauds equals the number of signal elements of the shortest duration transmitted per second. Thus, a speed of 60 words per minute or one signal element every 22 milliseconds is equal to $1000/22$ or 45 bauds. The speed in cycles per seconds and in bauds corresponding to any other number of words per minute may be calculated in a similar manner.

PERFORATED TAPES

In order to maintain the teletype system in operation at its maximum efficiency, it is convenient to prepare traffic in advance for transmission at a routine time. This is accomplished by recording messages in the form of coded perforations on a paper tape. The tape may be read and checked for accuracy before being fed into a device for automatic transmission by land line or radio.

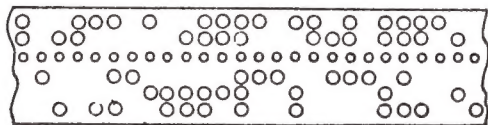


FIG 2-a Perforated teletypewriter tape.



FIG 2-b Partially perforated (chadless) teletypewriter tape.

A section of perforated teletype tape is shown in Figure 2. The small holes are feed holes which are used to feed the tape through the perforator and transmitting device. The tape may be read by moving it from right to left with the rough side up and with two recorded impulses above the feed lines and the three recorded impulses below the feed line. The tape is perforated for marking signals and is left unperforated for spacing signals. Start and stop signals are not recorded on the tape.

TYPES OF TAPES

Two different types of tape are in use in general teletype practice. The perforation in punching the tape leaves a circular hole by completely removing paper as shown in figure 2a. The pieces of tape removed by this operation are called chads and the tape removed is known as chad tape. When the reperforator or typing reperforator does not completely remove the circular piece of paper but leaves it in the tape securely by a small uncut portion the type of tape is called chadless tape and is shown in figure 2b.

PERFORATORS

The perforating mechanism consists essentially of a typing keyboard, a selecting mechanism, a punch hammer and set of punches for perforating the tape. The punch hammer is controlled by a pair

of electromagnets. When the key is struck to perforate the letter "A" (mark, mark, space, space, space) punch bars 1 and 2 are left in the part of their respective punches while punch bars 3, 4 and 5 are moved away from their punches. Then, when the punch magnet is energized, the hammer causes punches 1 and 2 to perforate the tape while punches 3, 4 and 5 are not operated. A feed hole is also punched with each forward motion of the punch hammer.

REPERFORATOR

A reperforator is a motor driven machine which receives electrically transmitted signals and converts these signals by mechanical means into code combinations perforated on a paper tape. In addition the message being received is printed on the tape. It is important to note that the perforations representing the printed letter is always six positions in advance of the letter. The reperforator is used to convert incoming messages, which would normally have to be retransmitted manually, into tapes which can be fed directly into the transmitting-distributor. This cuts down the handling of traffic and increases the speed with which messages can be relayed.

Another useful device in the teletype center is the typing reperforator. This machine is fitted with a keyboard for preparing tapes for subsequent transmission. In addition it may be used for perforating tapes from signals received from a distant station. It thus functions as either a perforator or as a reperforator.

TRANSMITTER-DISTRIBUTOR

The perforated tapes are fed into the transmitter-distributor unit for transmission over land line or radio links. When using the transmitter-distributor, no printed copy is produced at the transmitting end unless a separate printer is put into the line for this purpose. The tape is fed under a clip and over a line of five sensing pins. These pins open or close electrical contacts according to the perforations in the tape. Each pair of contacts is connected in series with one segment of a commutator-type distributor. A motor driven revolving brush sweeps over the commutator segments to open and close an electrical circuit according to the code for the character being sensed by the pins. The brushes connect the transmitting power to the line during marking signals and disconnect it during the spacing signals.

TELETYPE SIGNALS

A teletype signal consists of a series of square wave voltage pulses with the length of the pulse determined by the speed of transmission.

POLAR KEYING A teletype signal is said to be polarized, or polar keying is being employed, if the pulses are symmetrical about some reference point that is usually ground.

NEUTRAL KEYING Neutral keying is employed if the pulses of signal voltage are all above or below some reference point that is usually ground.

LANDLINE TELETYPE SIGNALS

General There are three general land line teletype systems. A land line teletype system is as its name implies, teletypes connected together by wires.

Neutral Landline System A neutral system is one in which current flows in one direction for a mark condition and no current flows during a space condition. This system can be used for a distance up to about one mile.

Polar Landline System A polar system is one in which the current flows in one direction for a mark and reverses for a space. This system requires a Polar Relay at both the receiving and transmitting end. A Polar Relay is a relay that is responsive to changes in direction of current. Since the teletype machine responds only to a neutral signal, the polar relay and its circuits produces the required neutral current flow. This system is good for a distance up to about ten miles

Tone On-Tone Off The Tone on-tone off landline system has an audio tone for a mark and no tone for a space, and can be used over any distance if amplifiers are used to boost the signal to compensate for line losses.

SINGLE AND DUPLEX OPERATION

Teletype operation which is limited to one direction over a circuit at one time is known as single or half-duplex operation.

When such a system is used, the receiver may not begin to transmit signals until the sender has terminated his transmission. With this type of operation, a break feature is usually provided to enable the receiver to stop the sender. A circuit in which independent transmission paths are provided for the two directions of transmission is known as a duplex or full-duplex circuit. A duplex system makes it possible to transmit signals in both directions over the loop at the same time without interference.

In teletype operation only one manual operation is required for each transmission character. Although a knowledge of the code is useful to the teletype operator, it is not essential. Communications by teletype consists of reproducing by electrical means at a remote

point the mechanical operations performed at the transmitting station. Each time the transmitting operator strikes a key to print a letter, the machine performs a series of mechanical operations and transmits a sequence of electrical impulses along the line to the receiver. These impulses operate a mechanical selector system in the receiver which selects the letter to be printed.

ADVANTAGES OF TELETYPE

The most obvious advantage of teletype is its speed. Although some operators can receive plain language at 60 words per minute, they can not do so for long periods of time. On a circuit where traffic is mostly code groups, the average speed over a long period of time seldom exceeds 15 words per minute. A teletype with its inherent speed of 60 or 100 words per minute will, therefore, move at least four times as much traffic as an operator sending by hand. More important is the fact that the addition of a teletype will increase the traffic capacity at least as much as adding three or four additional operators.

As far as accuracy is concerned, teletype sending is as subject to operator errors as any other system. When transmissions are monitored by the operator, it permits him to see an exact duplicate of the transmission. The teletype printer is inherently **accurate** and will not introduce garbles unless they are present in the input signals.

A third advantage of teletype is that traffic can be relayed automatically by means of perforated tapes. A tape perforating machine can be operated by the incoming signal, and this tape can be re-transmitted by mechanical means.

Another advantage of teletype over certain other means of high speed communications is that the copy is in a form which can be used immediately. Navy teletype equipment differs only slightly from the time proven commercial models you have seen in newspaper and telegraph offices. The most basic equipment is the Model 28 teletype. It is a page printer equipped with a keyboard, and may monitor outgoing messages. The resulting copy provides an ideal log and a fifth advantage of teletype.

The large scale use of shipboard teletype will certainly not make radiomen unnecessary although often making their work easier. The teletype printer is almost entirely mechanical. The machine is a marvel in perfection of design and is built to operate continuously. Regular servicing of the gear is essential. Tinkering is out. Practically every part is provided with an adjustment, and many must be made with micrometer precision. Radiomen go to a special school for a course in teletype maintenance. The ET does not maintain the teletype machine.

RADIO COMMUNICATIONS

In the history of Naval progress, communications play an increasingly important role. There was a time when visual devices were the only means of communication between ships and between a ship and the shore. The semaphore, the flag hoist and the flashing light were sight communications. When these were the only means of communication for a ship, out of sight meant out of communication. A ship alone on the high seas was isolated from the rest of the world.

Then came radio communications--first, the telegraph key with the dot and dash code that is now known as CW; and later voice radio communications. Now, a ship at sea could be in communication with other ships and the shore. Being out of sight no longer meant out of communications. The use of radio communications increased in volume as the number of circuits and the efficiency of the equipment improved. Radio systems soon were overloaded.

To lighten the load of CW and voice radio communications, the Navy needed a new means of dependable, rapid radio communication. The answer to the problem was radio teletype. The Navy uses two radio teletype systems afloat. One, the tone modulated system for short range operations, is similar to the familiar AM radio. The other, the carrier frequency shift system for long range operations, is similar to the standard FM radio. The two systems are shown integrated in Figure 3. This article describes the general principles that apply to the operation of radio teletype equipment.

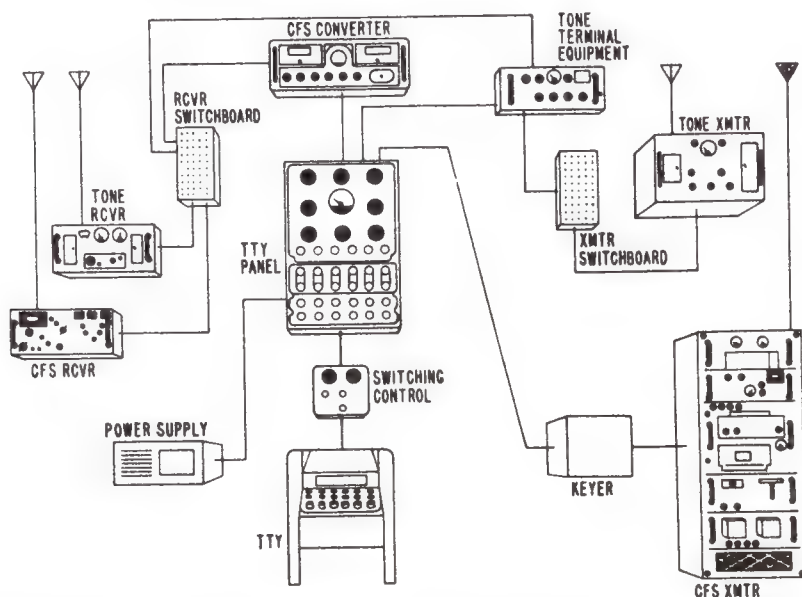


Figure 3 Basic radioteletype transmit-receive system

When the teletypes are not joined by wire operation is more complex. Direct current mark and space intervals cannot be sent through the air. The gap between the teletype machines must be bridged by radio and a radio transmitter and receiver is needed. The radio transmitter produces a radio frequency carrier wave to carry the mark and space intelligence. A keyer is needed to change the direct current pulses from the teletype into corresponding mark and space modulation for the transmitter. The radio receiver and a converter are required to change the radio frequency signal back to direct current pulses. The difference in the Navy's two radio teletype systems, as well as their names, are derived from the nature of the carrier wave used--the tone modulated carrier wave for short-range work and the carrier frequency shift system for long range work.

SHORT RANGE SYSTEM

To transmit messages by the short range system, a teletype, a tone terminal and a transmitter is used. The teletype sends out a direct current signal. The signal is changed to audio tones in the tone terminal. The transmitter impresses the audio tones on the carrier and sends out a tone modulated carrier wave as may be noted in figure 3.

To receive a message in the short range system, a radio receiver, a tone terminal and a teletype is needed. The tone modulated carrier wave enters the receiver which extracts the signal intelligence and sends the audio tones to the tone terminal. The terminal changes the tones into direct current mark and spaces for the teletype as per figure 3. In practice the same tone terminal is used for the receiving and sending circuits since it contains both a transmit keyer unit and a receiver converter unit.

LONG RANGE SYSTEM

At the transmitting end of the long range system is a teletype, a transmitter and a frequency shift keyer unit which is built into the newer transmitters. In the older systems the keyer is a separate piece of equipment. When the teletype is operated, the direct current teletype mark and space signals are changed by the keyer into frequency shift intervals which are transmitted as carrier frequency shift signals, as per figure 3.

On the receiving side of the long range system is a receiver, a frequency shift converter and a teletype. When the carrier frequency shift signal enters the receiver, it is detected and changed into a corresponding frequency shifted audio signal. The audio output of the receiver is fed to the converter, which changes the frequency shifted audio signal into the direct current mark and space teletype signals. See Figure 3.

INTEGRATED SYSTEM

When the carrier frequency shift system is combined with the tone modulated system, several more pieces of equipment are needed--a teletype panel, a power supply, a switching control, a transmitter switchboard, and a receiver switchboard. The teletype panel is capable of handling six channels or loops. The power supply furnishes the direct looping current for all teletype direct current signals. The transmitter switchboard and the receiver switchboard are used to integrate the radio teletype system with other communications systems on board ship. This results in a compact and flexible installation.

TYPES OF DISTORTION

General Misprinting in a radio teletype receiving installation can be attributed to three basic types of distortion. Figure 4a shows a perfectly spaced signal of the five unit code type at 60 words per minute. Radio distortion, illustrated by

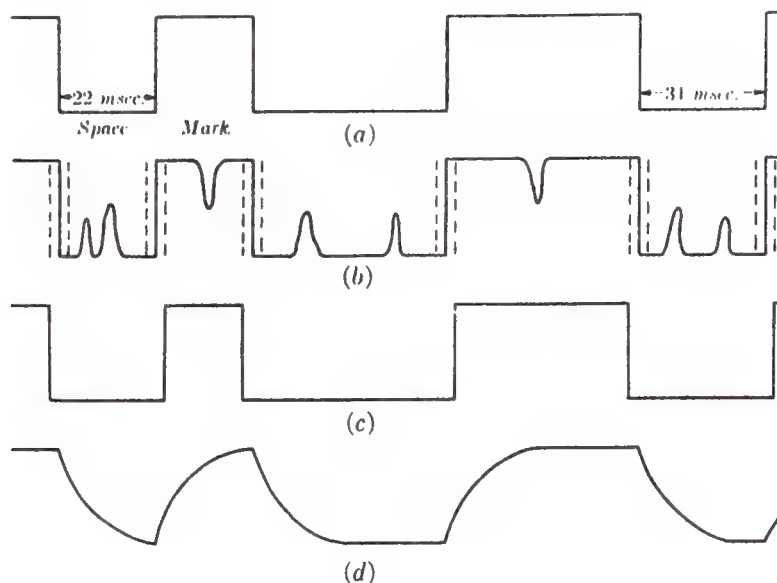


Fig. 4 Various types of distortion which may cause misprinting (a) Ideal signal waveform: (b) Radio distortion (c) Bias distortion (d) Characteristic distortion.

figure 4b is characterized by random time shifts of the edges of the signal elements. Breaks and indentations of the signal shapes may also occur due to irregularities of radio transmission and other fluctuations of the communications system. Figure 4c shows bias distortion which is the lengthening of the space signal at the expense of the mark signal or vice versa. Figure 4d shows characteristic distortion, that is, departure from the vertical in the leading and trailing edges of the pulses.

Radio Distortion Noise and interference signals are broadbanded and will find their way into the bandpass of the receiver, adding to the received signal. Very selective circuits will tend to reject signals outside the bandpass. Special filtering circuits are used in the audio portion of the receiver to limit bandpass to approximately 100 cycles per second. Filter transients, however, may reintroduce suppressed signals from outside the receiver bandpass into the receiver circuits.

Bias Distortion The requirement for perfect transmission is that the S-MTD (Space to Mark Transitional Delay) be equal to the M-STD (Mark to Space Transitional Delay). If the M-STD is greater than the S-MTD, all marks will be lengthened and all spaces will be shortened. This condition is known as marking or positive bias. If the S-MTD is greater than the M-STD, all marks will be shortened and all spaces will be lengthened. This condition is known as spacing or negative bias. Since the S-MTD and the M-STD are measured in milliseconds, the difference between the two is often referred to as millisecond bias.

In a neutral system the correct line current is necessary to develop the correct signals without distortion, assuming relays are correctly adjusted. If line current is below normal it will take a longer period of time to rise and overcome the mechanical constants of the relay to switch from space to mark. Thus, a decrease in line current in a neutral system produces spacing bias while an increase in line current produces marking bias.

Bias distortion, by definition, is the lengthening of the mark or space signal at the expense of the other. It is expressed in a percentage as:

$$\frac{\text{Mark length} - \text{Space length}}{\text{Mark length} + \text{Space length}} \times 100$$

For an acceptable minimum number of errors, teletype signals can contain no more than 5% bias. Distortion of this type, provided that the transmitted signal is undistorted, originates in the converter stages of the receiver.

The transition from mark to space does not take place instantaneously but does take a finite period of time. Ideally, this change from mark to space should take place at the midpoint of the transition in time. Mistuning the receiver and/or drifting receivers and transmitters will cause the mark-space relationship to change and bias distortion will result. Bias distortion, because it is caused by unbalanced voltages, ground potentials and relays out of adjustment, may vary from hour to hour on a circuit.

Characteristic Distortion Characteristic distortion is related to the amount and arrangement of the capacitance, inductance and resistance of a circuit. Characteristic distortion, because it is caused by the capacitance, inductance and resistance of the circuit, which, except for resistance, are unchanging in value, varies only a small amount from day to day on a given circuit.

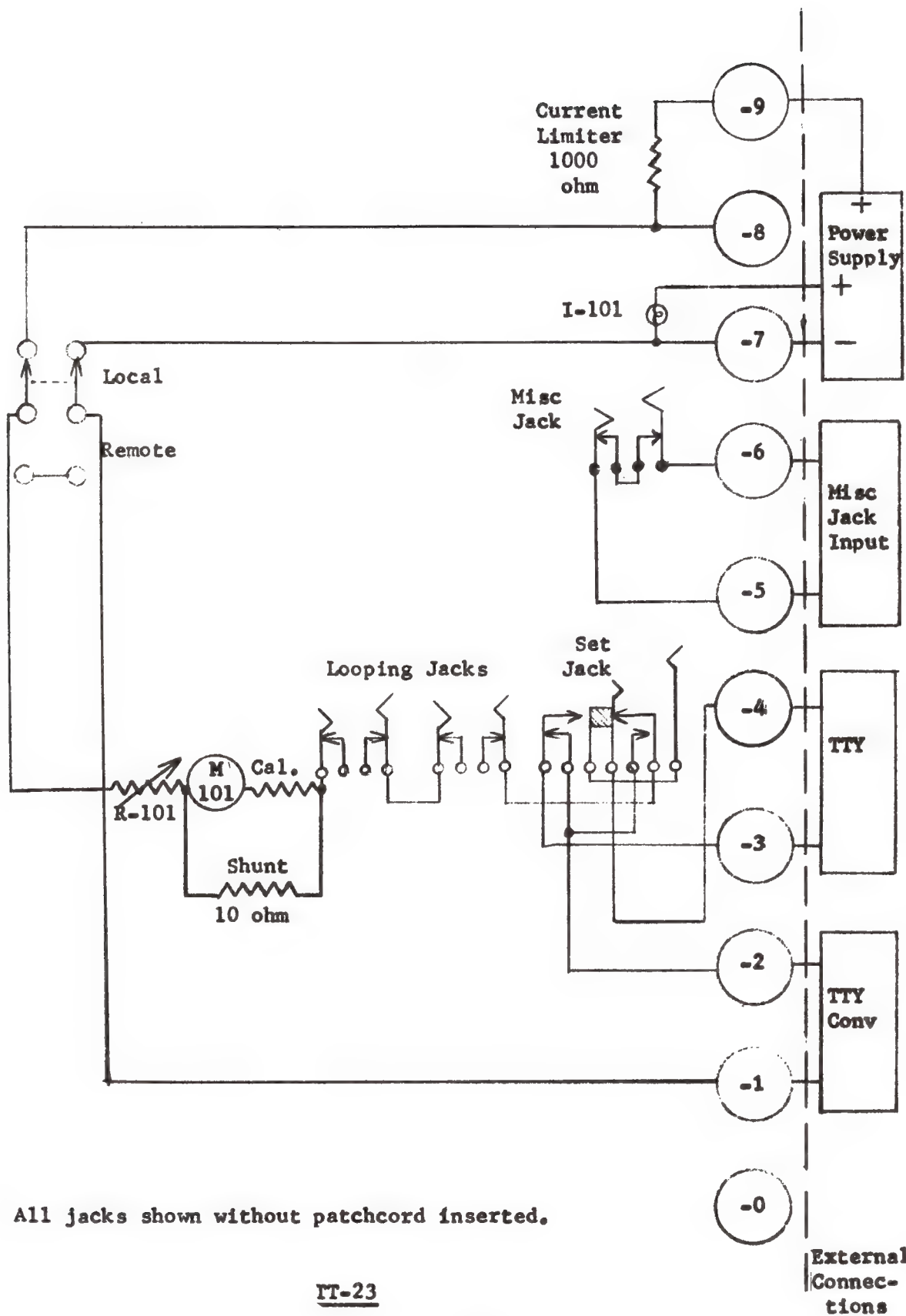
Fortuitous Distortion The form of distortion caused by such factors as powerline induction, momentary battery fluctuations, machine tolerances and other sporadic effects which displace miscellaneous received transitions by various amounts intermittently is known as fortuitous distortion. At times this effect may be large enough to produce a complete failure of the circuit. In the transmission of miscellaneous signals, the combined effect of characteristic and fortuitous distortion on the received transitions is sometimes known as jitters.

TELETYPE PATCH PANEL

The teletype panel interconnects the teletype with all the different radio keyers and converters as shown in figure 3. The teletype panel controls the direct looping current for six channels. When the teletype system is in operation, the current flows from the negative side of the power supply through the teletype panel, through the teletype, back through the panel a second time, and from there to the converter or keyer, through the teletype panel a third time and to the positive side of the power supply. When the direct current loop is alternately opened and closed by the teletype or one of the converters, the result is current and no current, or mark and space intervals that characterize the direct current teletype signal.

The looping current is controlled by a rheostat on the teletype patch panel. A common power supply is used for all teletype panels in shipboard installations. On the front panel in each of the six channels, or circuits, is a pair of looping jacks, a set jack, and a miscellaneous jack.

In both the tone modulated system and the carrier frequency shift system, all teletype signals pass through the teletype panel. The teletype panel integrates tone modulated and the carrier frequency shift systems. This operational flexibility gives maximum efficiency with the fewest circuits and the least amount of equipment in the Navy's compact radio teletype systems afloat.



All jacks shown without patchcord inserted.

TT-23

INTRODUCTION TO TELETYPE

A. STUDY ASSIGNMENT

1. Introduction to Teletype, Information sheet A3-N.
2. Study: Read and study the information sheet

B. STUDY QUESTIONS

1. List the four principle advantages of Teletype communications.
2. Describe Neutral Keying with respect to current conditions required for Mark and Space signals.
3. Describe Polar Keying with respect to current condition required for Mark and Space signals.
4. List the time duration for the seven impulses that are used in the make-up of a character or function in the Baudot Code, at 60 and 100 WPM.
5. Describe using a simplified drawing, the operation of the TTY Loop.
6. What is the purpose of the START and STOP pulses?
7. Describe using a simplified drawing, the operation of a Neutral Landline System and give its effective range.
8. Describe using a simplified drawing, the operation of a Polar Landline System and give its effective range.
9. List the operation of a TONE ON - TONE OFF Landline System with respect to tone condition, tone frequency, type of lines used and distance restrictions.
10. List the two causes of Bias Distortion.
11. with the use of diagrams, define Marking and Spacing Bias Distortion.
12. What is the major difference between Fortuitous and Characteristic distortion?

13. List the two methods of producing Applied bias to relays.
14. List the two modulation frequencies required in Two-Tone RATT.
15. State the teletype terminal equipment required for transmission and reception of Two-Tone RATT.
16. State the frequency spectrum normally used by Two-Tone RATT.
17. List the Navy standard shift frequencies for Mark and Space signals in FSK.
19. List the Mark and Space output frequencies of the receiver in FSK RATT.
20. What is the difference between a reperforator and a transmitter distributor?

TT-23/SG TELETYPE PATCH PANEL

A. STUDY ASSIGNMENT

1. NAVSHIPS 94037(B), Technical Manual for Communication Patching Panels TT-23/SG.
2. Study: Sections 1 and 4.

B. STUDY QUESTIONS

1. What is the basic purpose of the TT-23/SG Patch Panel?
2. What is the function of the Looping Jack with regards to its associated channel?
3. What is the purpose of the 1000 ohm and 2500 ohm resistors in the TT-23?
4. What are the functions of the Set Jack?
5. Describe the type of current flowing in the TT-23.
6. What is the condition resulting when a dummy plug is placed in a Looping Jack?
7. List the four steps required to patch a TTY printer into another loop in the TT-23, noting safety precautions to be observed.
8. What is the purpose of the Miscellaneous Jacks?
9. What is the purpose of a dummy plug?
10. Describe the purpose of the toggle switches on the TT-23.

AN/SGC-1A RADIO TELETYPE TERMINAL SET

A. STUDY ASSIGNMENT

1. NAVSHIPS 91503, Instruction Book for Radio Teletype Terminal Set AN/SGC-1A.
2. Study Sections 1 and 2.

B. STUDY QUESTIONS

1. Describe the general purpose of the Radio Teletype Terminal Set AN/SGC-1A.
2. List the following information for T-101 in the AN/SGC-1A:
 - a. Function
 - b. Input and output impedance
3. Describe the characteristics of the Receive Level Control E-101 (R-181).
4. List the frequency limits in C.P.S. and the attenuation value of the Band Pass Filter, Z101, in the receive section.
5. What frequencies are present at pins 2 and 5 of Z102?
6. Describe the type and function of the Receive Relay K101.
7. Describe the type and function of the Send Relay K102.
8. What are the two output frequencies of the Null Oscillator?
9. List the conditions of the relays in the Control Section for Receive, Standby, and Transmit.
10. List the following information for the Control Switch S-103:
 - a. The two position for receive
 - b. Contacts used for receive
11. What is the type of power supply used in the AN/SGC-1A.

12. List the three output voltages in the power supply.
13. List the following information for the 6 DB T-Pad:
 - a. Three components comprising the T-Pad
 - b. Purpose of the T-Pad
14. What is the purpose of T-102?
15. What type of limiting is performed by the first three Amplifier Limiters?
16. What is the approximate tube current change in V-103 or V-104 from static to dynamic conditions?
17. Which DC Amplifier is used for a Mark Condition?
18. List the following information for the ARC Suppressing Network:
 - a. Components
 - b. Use of components
 - c. Purpose
19. List the frequency outputs of the Null Oscillator for a Mark and a Space input from the TTY Loop.
20. What are the components of the Bridge T Network that compose the Null Network?
21. Describe the action of diodes CR-103 and CR-104, giving the reasons for this action with a Mark in the TTY Loop.
22. List the following information for the Two-Tone Amplifier:
 - a. Purpose of the resistor R-150
 - b. Purpose of parallel connections of the plates of triode V-106
 - c. Purpose of the unbypassed cathode resistor R-151.
23. List the following information concerning Z103:
 - a. Type of filter
 - b. Frequency range
24. What are the two functions of T-104?
25. List the three operating conditions of the Control Circuits.
26. How does the incoming signal change the SGC from Standby to Receive with the control switch in "AUTO"?

27. Define Standby Condition as referred to the AN/SGC-1A.
28. List the following information with respect to the AN/SGC-1A in the Standby Condition:
 - a. Conduction State of V-110
 - b. Condition of K-103
 - c. Condition of K-104
29. What is the charge and discharge path for C-106C?
30. List the three requirements to place the AN/SGC-1A in the Standby Condition.
31. List the purpose of each contact of the Receive Control Relay K103.
32. What is the condition of control relays K103 and K104 after the shift to the transmit condition?
33. List the steps required to energize the send control relay K-104 when switch S-103 is placed in the TRS position.
34. What is the charge and discharge path of C-114?
35. What is the time relationship of the charge and discharge time of C-114?
36. List the sequence for the equipment to return to standby from transmit in AUTO position of S-103.
37. List the purpose of all the contacts of the Transmit Control Relay K-104.
38. Redraw the metering circuit used for measuring Send Level, position 2 of the meter switch.
39. Redraw the metering circuit used for measuring Send Bias, position 1 of the meter switch.
40. Redraw the metering circuit used for measuring the Loop Current, position 3 of the meter switch.
41. What is the required meter reading on M-101 for proper loop current indication while adjusting R-133?
42. Redraw the metering circuit used for measuring the Receive Level, position 5 of the meter switch.
43. Redraw the metering circuit used for measuring the Plate Current, position 6 of the meter switch.

44. Redraw the metering circuit used for adjustment of Receive Bias, position 7 of the meter switch?
45. Explain the procedure of adjusting the Null Oscillator with the Control Switch placed in the ADJ FREQ position.

Familiarization AN/SGC-1,

INTRODUCTION: To be able to repair any Electronic Equipment you must be capable of opening the equipment, locating components, and closing the equipment. This portion of your troubleshooting procedure should be done in a minimum of time and for this reason you will thoroughly familiarize yourself with the AN/SGC-1A

REFERENCE: NavShips 91503, AN-SGC-1A Technical Manual

EQUIPMENT:

1. AN/SGC-1A
2. AN/URR-35
3. TTY Machine
4. Flat tip screwdriver,

SAFETY PRECAUTIONS:

1. High voltage is present on the cable input terminal strip
2. Do not plug earphones into "TTY MONITOR JACK." 110 volts DC is present at this point
3. Do not allow the TTY machine to run without loop current

JOB OUTLINE:1.The AN/SGC-1A Teletype Terminal Set is self-contained in one cabinet. Four knurled screws fasten the chassis to it's case. Cable entry is provided in the rear of the case and the electrical connection is made on a terminal strip mounted on the inside of the case. The chassis can be withdrawn from it's case and tilted in such a fashion that the underside is available for servicing. A utility outlet, 110 VAC, is provided on the front panel of the equipment.

2. Operating levels are set by adjusting the front panel controls. There are three adjustments, located on the right side of the chassis, that are used for initial adjustments and which rarely need changing. NOTE: VOLTAGES ARE PRESENT ON THE TERMINAL STRIP IN THE BOTTOM OF THE CASE.

3. Unfasten the four knurled screws which hold the chassis in the cabinet and withdraw the chassis. NOTE: THERE ARE MECHANICAL CATCHES WHICH PREVENT THE CHASSIS FROM BEING WITHDRAWN TOO FAR OUT OF THE CASE. THESE SHOULD LOCK THE CHASSIS IN THE OUT POSITION.

4. Observe the terminal strip in the rear of the equipment
5. Locate the following in the equipment:
 - a. Transmit Control Relay
 - b. Receive Control Relay
 - c. Send Relay
 - d. Receive Relay
6. Locate the following controls and briefly describe the location, title and purpose:

CONTROL	LOCATION	TITLE	PURPOSE
a. R-181			
b. R-128			
c. R-133			
d. R-163			
e. S-101			
f. S-102			
g. M-101			
h. J-101			
i. S-103			
j. R-150			
k. R-146			
l. R-147			

7. Operational and calibration procedures

a. Location of power switches

- (1) On-Off switch for the AN/SGC-1A is located on the lower left hand side of the front panel
- (2) On-Off switch on the Teletype Machine is located on the right hand side just below the keyboard

- b. Set the front panel controls on the AN/SGC-1A for normal operation
- (1) Turn the power switch on and allow the equipment to warm up for five minutes
 - (2) Turn the control switch to Transmit
 - (3) Patch the teletype machine to the appropriate AN/SGC-1A loop and complete the loop by placing a dummy plug into the appropriate set jack
 - (4) Turn the meter switch to the Loop Current position. Do not energize the teletype machine until you have at least 40 milliamperes of loop current
 - (5) Adjust the loop current potentiometer located on the front panel of the equipment fully clockwise
 - (6) Adjust the loop current to approximately 60 milliamperes using the line current adjust control and the meter located on the TT-23 patch panel
 - (7) Energize the teletype machine and readjust the loop current to 60 milliamperes. The final adjustment of the loop current should always be made with the teletype machine energized and in the loop
 - (8) Turn the control switch to AUTO
 - (9) Turn the meter switch to Send Bias
 - (10) Hold the space bar and the repeat button on the teletype machine down
 - (11) Meter on the equipment should read zero on the upper scale
 - (12) If meter does not read zero on upper scale, adjust send bias control, R-163, until you get a zero reading
 - (13) Release the space bar and repeat button when a zero reading is obtained
 - (14) Place the meter switch in the Send Level position
 - (15) Place the control switch in the Transmit position
 - (16) Using the Send Level Adjust, R-150, adjust the output for a reading of zero Db on the lower scale of the meter

- (17) Place the meter switch in the Plate Current position
- (18) Rotate the control switch to the Frequency Adjust position
- (19) Using the Mark Frequency Adjust, R-146, adjust for maximum deflection to the right, on the meter
- (20) Rotate the control switch to the Transmit position
- (21) De-energize the teletype machine
- (22) Insert a dummy plug into the teletype monitor Jack, J-101
- (23) Rotate the control switch to the Frequency Adjust position
- (24) Using the Space Frequency Adjust, R-147, adjust for a maximum deflection to the left on the meter
- (25) Remove the dummy plug from the teletype monitor jack
- (26) Energize the teletype machine
- (27) Place the Receive Bias Control to mid-range
- (28) Place the meter switch to the Receive Low position
- (29) Energize the AN/URR-35 receiver and allow to warm-up
- (30) Tune the receiver to the assigned frequency
- (31) Adjust the receiver output to approximately +5 DB
- (32) Adjust the Receive Level control, R-181, for a 0 DB reading on the lower meter scale of the equipment
- (33) The teletype machine should start printing
- (34) Wait until the teletype machine starts printing a series of space characters, then place the meter switch in the Receive Bias position. Note: you must be receiving space characters to adjust receive bias
- (35) Adjust the Receive Bias Control, R-128, for a reading of zero on the AN/SGC-1A meter on the upper scale
- (36) Place the meter switch to the OFF position

- (37) Your teletype machine should be printing good copy of the message
- (38) Staple one copy of the message being receive to your Job Sheet and turn your Job Sheet in to the Laboratory Instructor

TROUBLESHOOTING, AN/SGC-1A

INTRODUCTION:

1. Preventive maintenance and corrective maintenance is the goal of this course and at this point you will have your first troubles in the teletype system
2. The instructor will insert various troubles in the equipment which you are expected to locate. Isolation to an area is not enough; the actual trouble or component must be found
3. Fill out all information required so the instructor can give you constructive help

REFERENCES:

1. NavShips 91503, AN/SGC-1A Technical Manual
2. AN/SGC-1A Schematic Diagram

EQUIPMENT:

1. AN/SGC-1A, Terminal Equipment
2. AN/URR-35, Receiver
3. AN/USM-117, Oscilloscope
4. AN/URM-127, Audio Oscillator
5. AN/PSM-4, Volt-Ohmmeter
6. Flat tip screwdriver

SAFETY PRECAUTIONS:

1. Do not plug earphones into Teletype monitor jack, J-101
2. If AN/SGC-1A is turned off or if it is in standby, both transmit and receive lights will be off and loop current must not be over 36 milliamperes

JOB STEPS:

1. Through the use of your front panel controls, localize the trouble to one of the four sections - Transmit, Receive, Control Circuits or Power Supply

2. Explain what front panel indications led you to believe this section to be bad, and which circuits could cause these indications i.e. V-101, V-102 etc.

3. Using standard signal tracing methods, make checks to further localize the trouble. Indicate checks made and if the signal is normal or not

4. What circuit appears to be bad and why?

5. Use standard voltage measurement practices. Check circuit voltages and compare them to voltage chart in the instruction book

a. V-_____ Normal Actual

Pin 1

Pin 2

Pin 3

Pin 4

Pin 5

Pin 6

Pin 7

Pin 8

Pin 9

b. Other

6. Remove power from AN/SGC-1A. Remove loop voltage by placing the TT-23 local/external switch in the external position.
7. Make resistance checks to find and prove the trouble. Indicate checks made and how resistances compared to expected values

8. What component is bad?

AN/URA-8B AND THE RECEIVERS USED IN LAB.

A. INTRODUCTION The purpose of this information sheet is to familiarize the students with the controls that must be used for tuning the AN/URA-8B Converter/Comparator Group, and the associated receivers.

B. AN/URA-8B Controls and their functions:

1. Converter

a. Under the upper left-hand access panel.

(1) Narrow-Wide shift switch

This switch selects the proper input and noise filter for the deviation of the shifted signal. (Should be in the wide position, since the Navy uses only wide shifted signals).

(2) Speed Switch

Selects Fast or slow speed keying filters. (Should be in slow for speeds up to 60 WPM and in fast for speeds above 60 WPM.) Set to slow.

(3) Threshold (0-100)

Adjust bias (Axis) to keyer grid (V201B) Turn threshold control clockwise until the TTY machine starts to print. (Not used in DIVERSITY RECEPTION).

(4) Vertical Position

Adjust vertical position of the oscilloscope pattern (Adjust to make trace coincide with the centerline of the scope. This adjustment must be made with the receiver turned off).

b. Under the upper right-hand access panel.

(1) Horizontal Position

Adjust horizontal position of the Oscilloscope pattern. (Adjust to center trace on the face of the scope).

(2) Tone Oscillator

Used for tone-on/off operation on land lines.

(a) Frequency control switch.

Lets you select the frequency that you wish to use on your land line.

(b) Tone level control

Lets you adjust the tone level on your land line.

c. Regular front panel controls.

(1) Normal/Reverse switch.

This control reverses the polarity of discriminator output. Set to normal.

(2) Intensity Control

This control adjusts brightness of oscilloscope pattern. (Adjust for a trace on the scope).

(4) Focus Control

This control adjusts sharpness of oscilloscope pattern. (Adjust for a sharp, fine trace.)

(5) Tune/operate switch

This control allows you to tune your receivers without printing a lot of garble on the TTY machine tied to that channel converter.

2. Comparator

a. Under access door.

- | | |
|------------------------------|---|
| (1) Frequency Control Switch | Lets you select the frequency, that you wish to use with your tone on tone off operation on land lines. |
| (2) Tone level control | Lets you adjust the tone level on your land line. |

b. Regular front panel controls.

- | | |
|---------------|--|
| (1) Threshold | Adjust bias (axis) to keyer grid (V-705B).
(Turn this control clockwise until the teletype printer starts to print. good copy. |
| (2) Selector | Selectors input to comparator, to be used. (May be set in channel A or B for tuning purposes, but will be in combined for diversity reception. |

C. Receivers:

1. AN/SRR-13A for FSK reception.

a. Controls should be set as follows.

- | | |
|-------------------------|---|
| (1) B and Switch | To frequency range that includes the desired frequency. |
| (2) Tuning Dial | To desired frequency. |
| (3) Frequency Vernier | To Zero |
| (4) Antenna Compensator | To Zero |
| (5) Reception Switch | To FSK |
| (6) Calibrator | To off |
| (7) Output Meter Switch | To plus 20 |

(8) Silencer	To Zero
(9) Phone level	To good listening level
(10) AGC switch	To Normal
(11) Gain Control	Not Applicable

b. Calibration of the AN/SRR-13A

- (1) Turn tuning dial to nearest crystal check-point, marked with an inverted V. There is a check-point every 200KCS.
- (2) Turn the calibration switch to the ON position.
- (3) Turn the Output Meter Switch to the zero position.
- (4) Turn the gain control to 10
- (5) Adjust Tuning Dial for a zero-beat in the earphones. This is indicated by a peak on the tuning meter, and infinity in the negative direction on the output meter.
- (6) Loosen Cal. adjust locking screw and move the control until the Check-point is directly under the hairline.
- (7) Tighten Cal. Adjust locking screw and return all controls to normal operating position.

c. Tuning in the FSK signal.

- (1) Set the tuning dial to the Assigned Frequency.
 - (2) Watching the monitor scope on the **AN/URA-8B** adjust the Vernier Control for maximum separation of the upper and lower trace on the scope.
 - (3) Adjust Ant Comp. for Max. on Tuning Meter
 - (4) Adjust the Output to Odb.
2. R-390/URR for FSK signals: This procedure can be used for tuning the receiver to frequency shift signals, unless another is given.
The extremely sharp selectivity of the receiver requires exact tuning.

- a. Tune the receiver to the 100Kc check point nearest the assigned frequency
 - b. Turn the Function switch to Standby and allow two minutes to warm up
 - c. Turn the Band Width switch to 0.1Kc position
 - d. Turn the B.F.O. switch to ON
 - e. Turn Function Switch to CAL position
 - f. Turn Zero Adjust knob fully clockwise
 - g. Adjust the Kilocycle Change control for maximum, as indicated on the Carrier Level meter
 - h. Adjust the B.F.O. Pitch Control for a zero beat in the earphones. If knob does not indicate zero, loosen the set screw and reset the knob
 - i. Turn the Zero Adjust Knob fully counter clockwise
 - j. Set the Band Width control to 4 Kc position
 - k. Turn the function switch to AGC
 - l. Turn limiter switch off
 - m. Tune the Kilocycle Change Control to the assigned frequency
 - n. Adjust the B.F.O. Pitch for proper presentation on the terminal equipment scope
 - o. Place the line adjust gain to 0VU on the meter
 - p. Adjust the Line Gain Adjust to 0 VU on the meter
3. R-1051/URR for FSK signals: This procedure can be used for tuning the receiver for FSK reception
- a. Turn the reception switch to Standby, and allow the receiver to warm up for at least two minutes
 - b. Set the frequency selector switch three kilocycles below the assigned frequency
 - c. Place the cycle switch in the Vernier position

- d. Place the Upper Sideband Line Meter switch in +20Db position
- e. Place the Upper Sideband Line Gain about mid.-range
- f. Adjust the RF Gain Control fully clockwise
- g. Turn the Reception Switch to FSK
- h. Adjust the Vernier control for proper presentation on the terminal equipment monitor scope
- i. Adjust the Upper Line Gain Control for 0 Db output on the Line Meter

AN/URA-8B FREQUENCY SHIFT CONVERTER/COMPARATOR GROUP

A. STUDY ASSIGNMENT

1. NAVSHIPS 91490 Instruction Book for Frequency Shift Converter/Comparator Group AN/URA-8B
2. Study Sections 1 and 2

B. STUDY QUESTIONS

1. What is the major advantage of HF operation of FSK over UHF or VHF with respect to frequency drift.
2. What are the two types of Diversity Reception and explain where each is used?
3. What is the use of Tone-On/Tone-Off output of the converter?
4. What is the major requirement of a receiver to be used with the AN/URA-8B?
5. List the two frequencies received from the receiver and their use in the AN/URA-8B.
6. Describe the AF Oscillator's:
 - a. Frequency range
 - b. Number of steps in range
 - c. Frequency interval between steps
 - d. Use for external signal in
7. List the following for each of the Input Filters, Z101 and Z102:
 - a. Flat response frequency range
 - b. Center frequency
 - c. frequency limits
 - d. Impedance
 - e. Purpose

8. List the following information in describing the Limiting Amplifiers V101A and V101B:
 - a. Type of amplifier configuration
 - b. Two type of limiting employed
 - c. Input power limits for maintaining constant level
 - d. Components employed to furnish bias to first stage
 - e. Component used for positive peak limiting
 - f. Method used for negative peak limiting
 - g. Bias used on second stage
9. List the following information in describing the Discriminator Rectifiers V103A and V103B:
 - a. Frequency accommodated with each rectifier
 - b. Purpose
 - c. Switch associated with outputs
 - d. Where the output signal is fed to.
10. List the following information in describing the normal operation of the Discriminator Rectifier for both Mark and Space signal inputs:
 - a. Frequency of signal
 - b. Tube with associated circuit components to accomplish rectification
 - c. Type of signal and component used to develop the signal.
11. What is the purpose of the normal-reverse switch, S-102?
12. List the three places to which the output of the Fast-Slow Filter, Z-105, are fed.
13. What are the two main purposes of the Axis Restorer?
14. Draw a simplified diagram of the Axis-Restorer, V104 and V105, and explain its operation.
15. Explain a mark weighted signal with respect to its composition and effect on the axis.
16. Explain a space weighted signal with respect to its composition and effect on the axis.
17. What is the condition of the TTY loop and machine for the following signals present at the axis restorer:
 - a. Normal signals
 - b. No signals
 - c. Prolong mark or space

18. List the following information in describing the Keyer Circuit operation with a Mark input:
 - a. Polarity of input signal to V201B
 - b. Action of plate voltage of V201B
 - c. Action of change in plate voltage of V204B on plate potential of V205
 - d. Conduction path of V-205 with voltage limits at extremes of circuit.
 - e. Voltage distribution of conduction path of V205
19. List the following information in describing the Keyer Circuit operation with a Space input:
 - a. Polarity and amplitude of signal on the grid of V201B
 - b. Action of plate change of V201B
 - c. Action of change in plate voltage of V-201B on the grid of V204B.
 - d. Action of plate voltage of V204B.
 - e. Amplitudy of voltage on plate of V205.
 - f. Voltage applied to the grids of the Electronic Relay
 - g. Conduction condition of the Electronic Relay
 - h. Current condition in the TTY loop.
20. List the following information in describing the Electronic Relay V207 and V208:
 - a. Connection with respect to the TTY Loop.
 - b. Conduction condition for Mark and Space input.
 - c. Amplitude of current conduction of each tube.
 - d. Source of plate voltage.
21. List the following information in describing the Audio-Oscillator-Amplifier circuit V201A and V203A:
 - a. Type of circuit connection of the two tubes.
 - b. Cause for oscillation to occur.
 - c. Frequency determining components.
 - d. Negative feedback path
22. Describe the operation of the Oscillator-Amplifier-Regulator, V203B, with respect to its purpose and the voltage fed to the grid of V203A.

23. List the following information id describing the Tone Modulator V206:
 - a. Tube connection
 - b. Source of bias supply
 - c. Bias supply for Mark input
 - d. Tube operation with Mark input bias
 - e. Bias supply for Space input
 - f. Tube operation with Space input bias
 - g. Value of cut-off bias when applied
24. List the following information in describing the output circuit of the Oscillator-Keyer-Sub Unit:
 - a. Purpose of R-220
 - b. Purpose of C-224
 - c. Purpose of R-221 and C-225
25. What is the two purposes of the Monitor Sub-Unit?
26. Describe the Cycle Shift Control R-201 with respect to its control and its calibration.
27. Describe the Monitor Sub-Unit with respect to the following:
 - a. Type of oscilloscope circuit
 - b. Use of V301A
 - c. Sweep speed
 - d. Operation controls
 - e. High Voltage and source
28. Describe the Power Supply Unit with respect to the following:
 - a. Type rectifier circuit
 - b. Type of filter circuit
 - c. Source of -38 Volt supply
 - d. Purpose of the link E-401 in the primary of T401
29. Describe the Comparator Unit, CM-22A/URA-8B, with respect to the following:
 - a. When used
 - b. Source of comparison
 - c. Method of selection
 - d. Five units essentially the same as in the Converter, CV-89A/URA-8B
 - e. Two circuits containing differences

30. List the following information in describing the action of the Comparing and Selecting Circuit:
- a. Position of switch S-701
 - b. Application of "A" signal
 - c. Application of "B" signal
 - d. Action of Positive pulses to V-701
 - e. Action of Negative pulses to V-702
 - f. Circuit acceptance of "A" and "B" sources
 - g. Path of output
31. What are the two differences in the circuit action of the Axis Restorer with respect to the Axis Restorer in the Converter, CV-89A/URA-8B?

AN-URA-8B, Familiarization

INTRODUCTION:

1. The purpose of this job sheet is to familiarize you with the various operating controls of the AN-URA-8B
2. You will set up the AN-URA-8B for diversity reception and note the effect of the various controls and switches. You will note the results on the monitor scope, and on the Teletype machine

EQUIPMENT:

1. AN-URA-8B, Teletype Converter/Comparator
2. Radio receiver, 2
3. Teletype machine
4. Headphone set
5. Screwdriver

REFERENCES:

1. NavShips 91490, AN-URA-8B, Instruction Book
2. AN-URA-8B, Information Sheet

SAFETY PRECAUTIONS:

1. Do not energize the teletype machine until you have loop current
2. Do not plug earphones into the Teletype monitor jack on the AN-URA-8B Converter/Comparator

JOB STEPS:

1. Turn on the receivers and the AN-URA-8B
 - a. Power switches are located on the front panel of the equipment
 - b. Allow the equipments to warm up for two minutes

NOTE: DO NOT TURN ON THE TELETYPE MACHINE UNTIL YOU HAVE LOOP CURRENT

2. Turn on the Teletype machine. The power switch for the teletype machine is located on the right hand side under the keyboard.
3. Adjust the loop current for a reading of 60 milliamperes on the TT-23 patch panel meter
4. Adjust the receivers for FSK operation as set forth in the information sheet.
5. Make preliminary settings on the AN-URA-8B. Refer to the AN-URA-8B information sheet
6. Tune the receivers with the normal-reverse switch of the AN-URA-8B in the normal position
 - a. Tune the top receiver first
 - b. Approach the desired frequency from the low frequency side
 - c. The instructor will designate the frequencies to be used
 - d. Adjust the scope pattern correctly according to the information sheet
7. Make operating adjustments to the AN-URA-8B
 - a. Set comparator selector switch to the Channel A position
 - b. Turn the Threshold Control on the comparator clockwise until the teletype machine starts to print
 - c. If you have the proper signal presentation on the monitor scope and the teletype machine is not printing good copy, place the channel A normal-reverse switch in the reverse position
 - d. If the teletype machine starts printing good copy continue with the following job steps, if not repeat steps 4 through 7
 - e. Set comparator selector switch to the Channel B position and repeat job steps 4 through 7 using the bottom receiver and Channel B

8. Place the AN-URA-8B comparator switch in the diversity position indicated as combined
 - a. Readjust the comparator threshold control to the highest scale reading which will not allow noise pulses to cause errors in the printed copy
 - b. A practical procedure for making this adjustment is as follows
 - (1) Detune both receivers until noise alone is received
 - (2) Turn the threshold control clockwise until noise causes garble on the printer
 - (3) Then turn the threshold control counter-clockwise until you no longer have false keying on the teletype machine
 - (4) Leave the threshold control at this level
 - (5) Retune the receivers and get good copy on the teletype
9. Have your work checked by the instructor

AN-URA-8B, TROUBLESHOOTING

INTRODUCTION

1. This job sheet is designed to give you experience in troubleshooting.
2. The instructor will place troubles in the equipment and the students will locate the troubles. The steps followed in locating the defective component will be listed so the instructor can guide the student in developing the most efficient troubleshooting technique.
3. The student must locate the actual defective component

EQUIPMENTS

1. AN-URA-8B, Teletype Terminal Equipment
2. Radio Receivers, 2
3. AN-PSM-4B Multimeter
4. AN-URM-127, Audio Signal Generator
5. AN-USM-34, Vacuum Tube Voltmeter
6. AN-USM-117, Oscilloscope

REFERENCES:

1. NavShips 91490, AN-URA-8B, Instruction Book
2. Schematic Diagrams, AN-URA-8B

SAFETY PRECAUTIONS:

1. Do not plug earphones into TTY monitor jacks
2. De-energize AN-URA-8B drawers before pulling them out of case
3. Place the inter-connecting cable into the back of the case when you are finished with it during a check

JOB STEPS

1. Through the use of the frontpanel controls determine which drawer is bad: Converter A, Converter B, Comparator or a combination of these three. List the drawer that is bad.
2. Isolate the trouble to one of the sub units of drawer listed above, using front panel controls. List the sub unit that is bad.
3. Explain the front panel indications that led you to believe that this sub unit was bad. List below the possible circuits also that could cause these symptoms
4. Using standard signal tracing methods, make the checks that you feel should be made to further localize the trouble to a particular circuit. Indicate below the checks made and if the signal was normal or not. What circuit appears to be bad and why?

5. Using standard voltage measuring practices, check circuit voltages and compare them to the voltage chart in the instruction book. Complete the following chart:

V-_____	Normal	Actual
Pin 1		
Pin 2		
Pin 3		
Pin 4		
Pin 5		
Pin 6		
Pin 7		
Pin 8		
Pin 9		
Other		

What readings are outside of tolerance and an indication of troubles?

6. Deenergize the drawer and remove and stow the interconnecting cable
7. Take resistance checks to find and prove the trouble. What resistance check made you feel that you had found the defective component? Why?
8. What component is bad?

FREQUENCY SHIFT CONVERTER, AN/URA-17

A. STUDY ASSIGNMENT

1. NAVSHIPS 94028, Technical Manual for Comparator-Converter Group AN/URA-17.
2. Study: Sections 1 and 4.

B. STUDY QUESTIONS

1. Describe the purpose of the AN/URA-17 terminal equipment.
2. What are the two center frequencies of the two possible input signals?
3. What is the cycle shift range that maybe used in narrow and wide shift?
4. What is the maximum possible keying speed?
5. List the function of the following units of the block diagram:
 - a. Bandpass filters
 - b. Limiter
 - c. Discriminator
 - d. Mark-Space Amplifier
 - e. Detector
 - f. Keying filters
 - g. DC Differential Amplifier
 - h. Axis Restorer
 - i. Comparator
 - j. DC Limiter
 - k. Loop Keyer
 - l. Mark Lockup
 - m. Tuning Indicator
 - n. Power Supplies

6. What is the purpose of R-84?
7. Describe the circuit sequence when the output voltage rises and the three transistor regulator circuit compensates for the voltage rise.
8. What is the normal mark and space input frequencies to the terminal equipment?
9. What are the impedances that the input transformer Z1 must match?
10. What are the bandpass characteristics of the filters Z1 and FL1?
11. Describe the purpose and operation of diode limiters CR1 and CR2.
12. List the frequency response characteristics of the narrow and wide discriminator filters.
13. List the static voltage conditions on the first and second mark and space amplifiers.
14. Draw the development of DC pulses at the detector load resistors R-25 and R-26.
15. What is the reason for polarity switch S2?
16. What is the upper speed range for the slow and fast speed keying filter?
17. How is the static bias on transistors Q6, Q7, Q8, Q9, and Q10 developed?
18. What is the purpose of R-39, the linearity control?
19. Redraw the feedback stabilization circuit of differential amplifier from R-41 through Q8, Q9, and Q10.
20. State the positive signal path in the axis restorer with respect to the following:
 - a. Charge path for C-17 and C-18.
 - b. Conduction of CR-9 and CR-10.
 - c. Voltage developed across R-45 and R-46.
 - d. Charge path for C-19 and C-20.
 - e. Polarity of the signal to comparator.

21. State the negative signal path in the axis restorer with respect to the following:
 - a. Discharge and charge path of C-19 and C-20.
 - b. Conduction of CR-10 and CR-9.
 - c. Voltage developed across R-45 and R-46.
 - d. Discharge and charge path of C-17 and C-18.
 - e. Polarity of signal to the comparator.
22. Describe the circuitry involved in tune to have an output signal slightly positive.
23. What is the input signal to the four transistor DC limiter circuit?
24. List the following with reference to the loop keyer circuit:
 - a. Purpose of CR-20.
 - b. Purpose of CR-21 and CR-22.
 - c. Purpose of CR-19.
 - d. Purpose of CR-18.
 - e. Source of 120 VDC, 60 ma, for Q-17 and Q-18.
 - f. Purpose of R-67.
25. Describe the conditions under which the mark lock-up circuits hold the teletype loop closed.
26. What type of signal will pass through CR-11?
27. What is the conducting condition of Q-11 and Q-12 when a normal signal is received?
28. What is the approximate potential at the junction of R-52 and R-53 when Q-12 conducts?
29. Describe the charge-discharge paths of C-32.
30. Where is the source of the tuning indicator high voltage?
31. Describe the indicator pattern and voltage changes as R-77 and R-80 are varied.
32. What is the correct setting of level control R-4 with respect to the pattern observed on the tuning indicator?

AN/URA-17, FAMILIARIZATION

INTRODUCTION:

1. This job sheet is designed to give you some experience using test equipment and familiarizing you with the adjustments to the AN/URA-17 terminal equipment

EQUIPMENT:

1. AN/URA-17, Converter/Comparator Teletype Terminal Equipment
2. Radio Receivers, 2
3. AN/UPM-206, Transistor Checker
4. AN/USM-117, Oscilloscope
5. AN/URM-127, Audio Signal Generator
6. AN/PSM-4B, Multimeter
7. Vacuum Tube Voltmeter
8. Screwdriver

REFERENCES:

1. NavShips 94028, Instruction Book for AN/URA-17 equipment
2. Schematic Diagrams for AN/URA-17

SAFETY PRECAUTIONS:

1. Observe all normal safety precautions
2. Do not pull any transistor from its socket without securing the AC power to the equipment

JOB STEPS:

1. Power Supply Adjustments

a. +48 volt power supply

Psm 4

- (1) Withdraw the chassis to the stops on the drawer slides and operate the interlock switches by pressing in on the button at the left side of the switch block.
- (2) Connect the common black lead from the multimeter to the equipment chassis, and the positive lead to the red testpoint, TP-8.
- (3) Adjust multimeter to appropriate DC scale to read the voltage
- (4) Turn the converter power on and allow the equipment to warm up for two minutes
- (5) Adjust the +48 volt adjust control, R-89, for multimeter indication of +48 volts.

b. -48 volt power supply

Psm 4

- (1) Turn the equipment off. Place the multimeter in the negative DC position.
- (2) Place the positive red testlead in test point TP-7
- (3) Turn the equipment on and allow to warm up for two minutes
- (4) Adjust the -48 volt adjust control, R-72, for multimeter indication of -48 volts. Turn equipment off and remove test leads.

c. Cathode Ray Tube Adjustments

Very Carefully

- (1) Adjust Focus control R-92 for proper focus on the scope
- (2) Adjust intensity control R-93 for good intensity on the scope
- (3) Short black test point TP-4 to the chassis with a clip lead
- (4) Adjust Vertical Adjust Control R-80 to center trace on the scope bezel. Remove the TP-4 short.
- (5) Adjust horizontal centering control R-77 to center the trace on the CRT bezel.
- (6) If trace on CRT bezel is not horizontal, loosen the clamp at the CRT base and rotate until trace is horizontal. Then tighten clamp.

d. Mark and Space Gain Control Adjustments

VTVM

- (1) Connect VTVM and Audio Oscillator to the power source and allow at least a two minute warmup period
- VTVM AC scale* —(2) Adjust converter level control to 6, set shift switch to wide and speed switch to slow

- (3) Disconnect the Audio input cable connector J-2 on the rear of the converter
- (4) Adjust the Audio Oscillator frequency to 2550 CPS
- (5) Connect the audio output of the oscillator to the input terminals of Z-1, pins 1 and 3
- (6) Adjust oscillator output for an output of six volts
- (7) Set the VTVM range to 1 volt and connect the VTVM between terminals 1 of FL3 and the converter chassis. Record the reading *Approx. 22 volts (AC Function) 32*
- (8) Move the VTVM lead from terminal 1 to terminal 4. *24*
Adjust the VTVM range as necessary. Record the reading *Approx 24 volts*
- (9) Adjust audio oscillator frequency and repeat steps 7 and 8 until the voltages at terminals 1 and 4 are equal. Maintain constant oscillator output. This will place the oscillator at the electrical crossover point of the filter and its circuitry *23 volts (approx)*
- (10) Move the VTVM lead from Terminal 1 or 4 of FL3 to the green test point, TP-3. Adjust the Space Gain Control R-17 for a 4 volt VTVM indication
- (11) Move the VTVM lead from TP-3 to the blue test point, TP-2 and adjust the Mark Gain control, R-96, for a 4 volt indication
- (12) Repeat steps 10 and 11 until 4 volts is indicated at TP-2 and TP-3. The mark and space signals leaving the discriminator will then be equal

e. DC Differential Amplifier Adjustments

- (1) Adjust converter level control to 0 and set polarity switch to normal
- (2) Adjust multimeter to the 50 volt range
- (3) Move the positive test lead of the multimeter to TP-4
- (4) Adjust Vertical Centering Control R-31 for a zero reading on multimeter. Change voltage range as required for an exact setting of R-31. *db 5-13*
- (5) Adjust Audio Oscillator for an output frequency of 3200CPS
- (6) Adjust Audio Oscillator for an output of 6 volts
- (7) Readjust Multimeter to 50 volt range
- (8) Adjust level control to 6
- (9) Adjust Linearity Control, R-39, for +32 volts on multimeter *PSM 21*
- (10) Adjust Level Control to 0 and Audio Oscillator to 0 volt output. Readjust R-31 for 0 meter reading *use PSM 4*
- (11) Adjust Audio Oscillator for 6 volt output, and return Level Control to 6
- (12) Adjust R-39 Linearity Control for equal positive and negative readings when the Polarity Switch is changed from Normal to Reverse
- (13) Deenergize the test equipment and reconnect the audio input to J-2

f. Tuning Procedure

- (1) Set level control to 3 and shift control to wide
- (2) Set function switch to tune and polarity switch to normal
- (3) Set speed switch to slow
- (4) Tune the receiver for proper signal indication of the monitor scope
- (5) Turn the teletype on and adjust loop current to 60 ma.
- (6) Place function switch in the diversity position
- (7) The teletype should start printing. If it does not print properly throw the polarity switch to reverse. When the teletype prints properly have the instructor check your work. If the teletype does not print properly repeat steps 1 through 7.

NOTE: After the instructor has checked your work start working on the next Job Sheet

AN/URA-17, Testing of Components

INTRODUCTION:

1. This job sheet is designed to familiarize you with the methods of checking the bandpass of filters and in the use of a transistor checker

EQUIPMENT:

1. AN/URA-17, Teletype Terminal Equipment
2. AN/USM-34, Vacuum Tube Voltmeter
3. AN/PSM-4B, Multimeter
4. AN/USM-206, Transistor Checker
5. AN/URM-127, Audio Oscillator
6. OS-8/U, Oscilloscope

REFERENCES:

1. NavShips 94028, AN/URA-17 instruction book
2. AN/URA-17 Schematic Diagrams

SAFETY PRECAUTIONS:

1. Do not attach any leads in the AN/URA-17 with the equipment energized
2. Do not remove any transistor from its socket with the equipment energized
3. Insure that all equipments are commonly grounded

JOB STEPS:

1. Check filter tolerance as per instruction book, Bandpass Filter Tests, Page 6-4, Paragraph (6) to Page 6-6, Paragraph (7).

2. Test the quality of the discriminator circuits . Complete all steps listed on page 6-6, paragraph (7) to page 6-9, paragraph (8).
3. Test the low pass keying circuits. Complete all steps listed on pages 6-9 and 6-10, paragraph(8).
4. Check the quality of certain transistors. Use the Transistor Tester Instruction Book and check transistors Q-17 and Q-18 of the AN/URA-17 Bravo Converter.

Read
1-13
do
Quest.
1-20
14+15